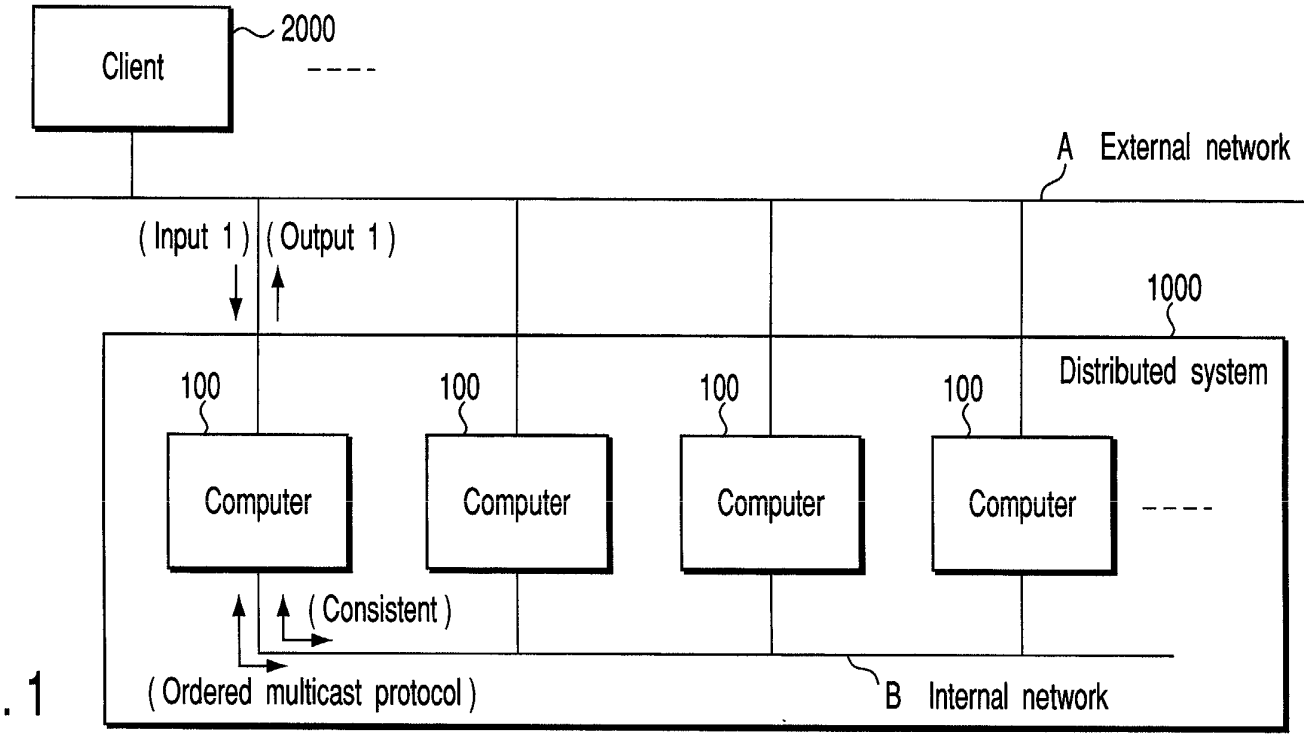
Client
2000
A External network
(Input 1)
(Output 1)
1000
Distributed system
100
100
100
100
Computer
Computer
Computer
Computer
(Consistent)
(Ordered multicast protocol)
B Internal network

FIG. 1

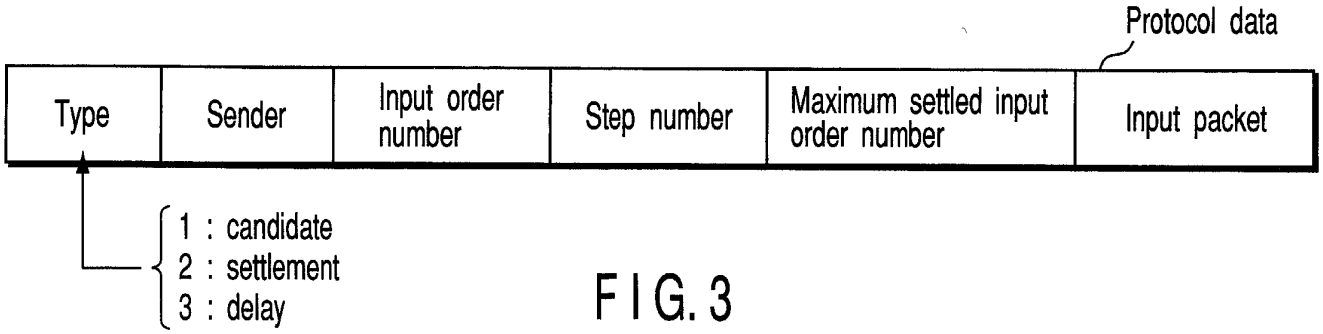
Protocol data
Type
Sender
Input order number
Step number
Maximum settled input order number
Input packet
1 : candidate
2 : settlement
3 : delay

FIG. 3

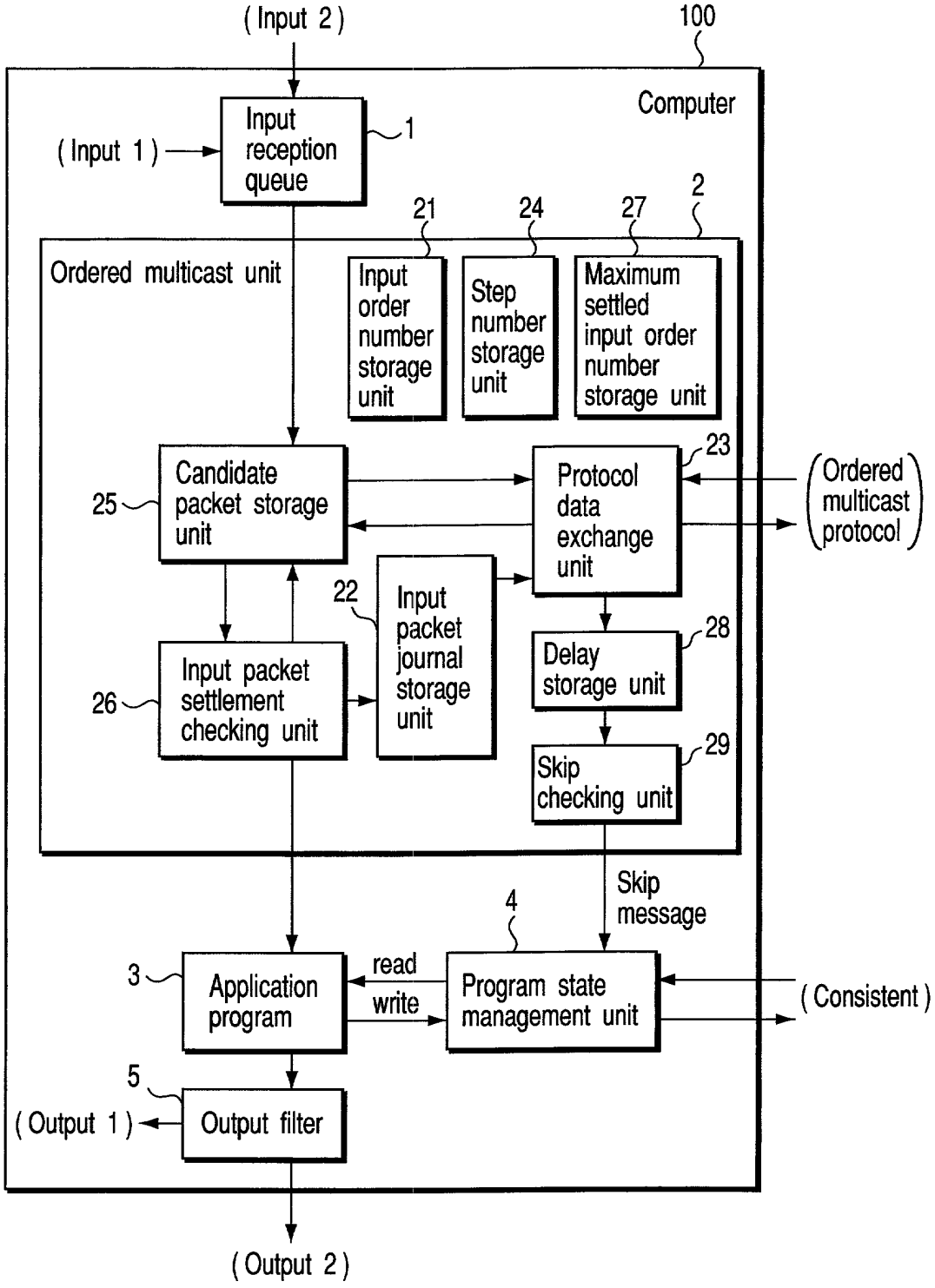
(Input 2)
100
Computer
(Input 1)
Input reception queue
1
2
21
24
27
Ordered multicast unit
Input order number storage unit
Step number storage unit
Maximum settled input order number storage unit
23
Candidate packet storage unit
25
Protocol data exchange unit
(Ordered multicast protocol)
22
Input packet journal storage unit
28
Delay storage unit
Input packet settlement checking unit
26
29
Skip checking unit
Skip message
4
3
Application program
read
write
Program state management unit
(Consistent)
5
(Output 1)
Output filter
(Output 2)

FIG. 2

	Computer (1)	Computer (2)	Computer (3)	Computer (4)
1	A (Select candidate)	A (Select candidate)	B (Select candidate)	C (Select candidate)
2	[A(1), A(2), B(3)] (Generate candidate list)	[A(1), A(2), C(4)] (Generate candidate list)	[A(2), B(3), C(4)] (Generate candidate list)	[A(1), A(2), C(4)] (Generate candidate list)
3	A (Select candidate)	A (Select candidate)	C (Select candidate)	A (Select candidate)
4	[A(1), A(2), A(4)] (Generate candidate list)	[A(1), A(2), C(3)] (Generate candidate list)	[A(1), A(2), C(3)] (Generate candidate list)	[A(2), C(3), A(4)] (Generate candidate list)
5	Determine (A)	A (Select candidate)	A (Select candidate)	A (Select candidate)
6	———	[A(1), A(2), A(3)] (Generate candidate list)	[A(2), A(3), A(4)] (Generate candidate list)	[A(2), A(3), A(4)] (Generate candidate list)
7	———	Determine (A)	Determine (A)	Determine (A)
⋮	⋮	⋮	⋮	⋮

FIG. 4

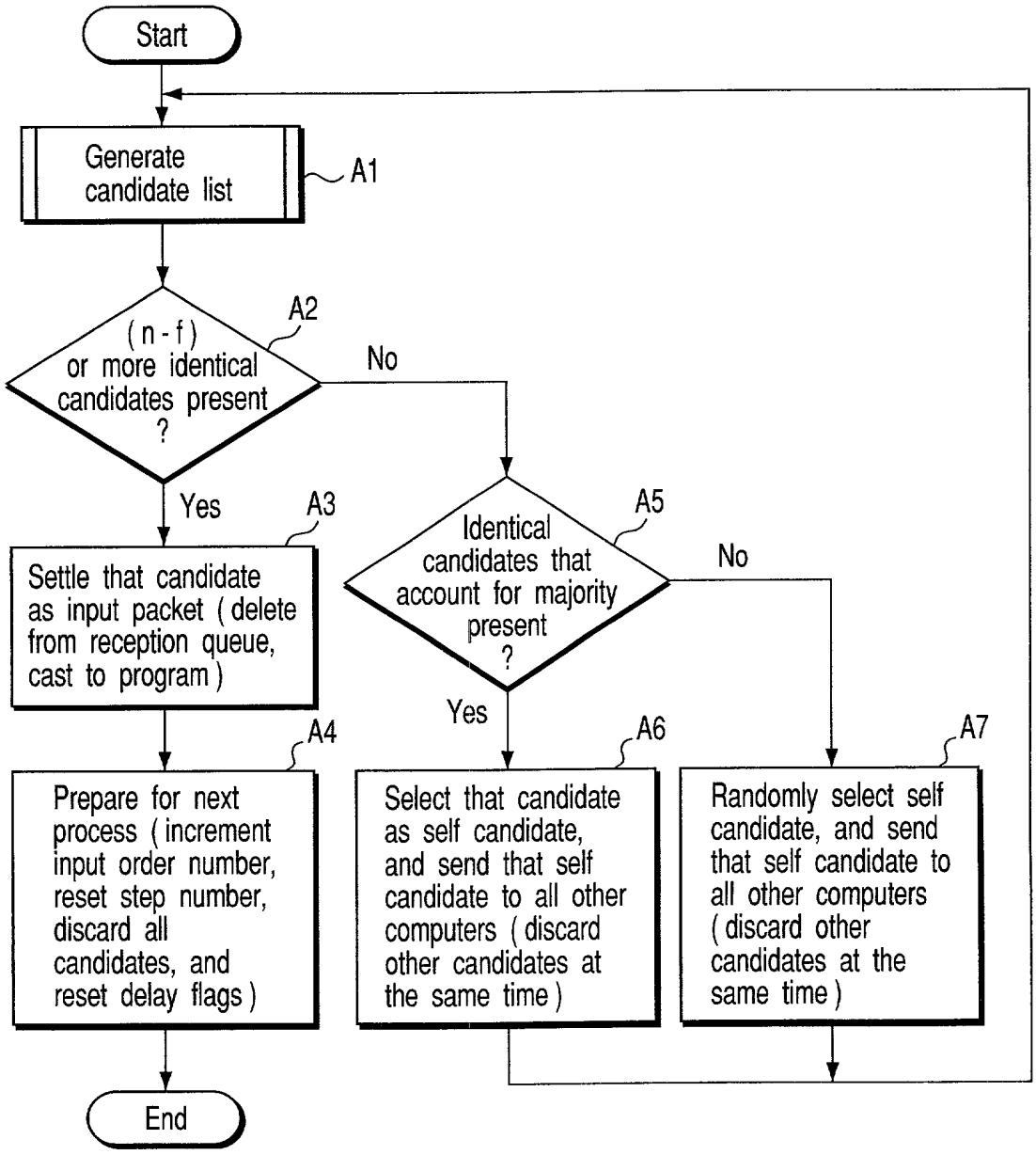
Start
Generate candidate list
A1
(n - f) or more identical candidates present ?
A2
No
Yes
A3
Settle that candidate as input packet (delete from reception queue, cast to program)
A4
Prepare for next process (increment input order number, reset step number, discard all candidates, and reset delay flags)
End
Identical candidates that account for majority present ?
A5
No
Yes
A6
Select that candidate as self candidate, and send that self candidate to all other computers (discard other candidates at the same time)
A7
Randomly select self candidate, and send that self candidate to all other computers (discard other candidates at the same time)

FIG. 5

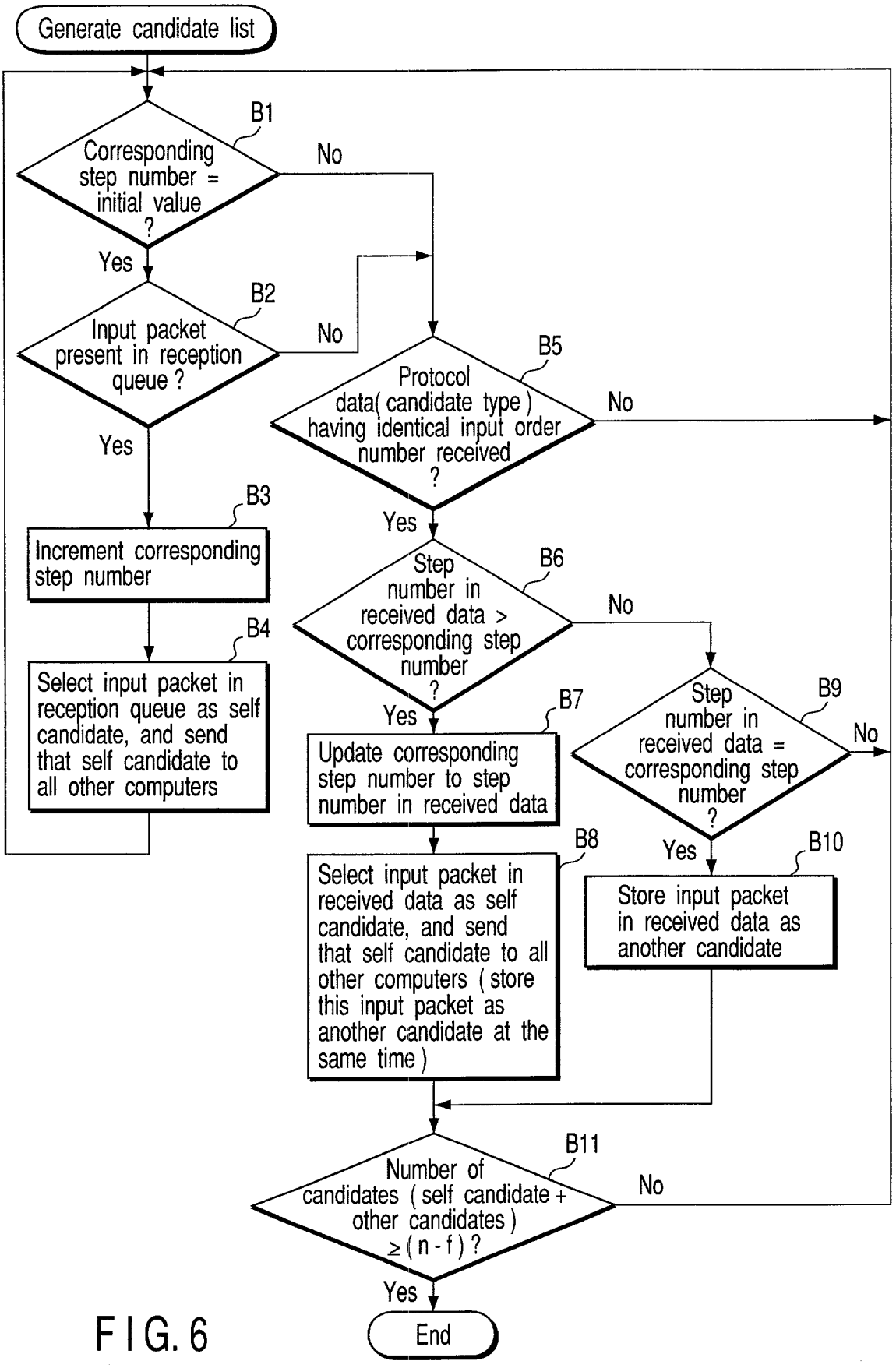
Generate candidate list
B1
Corresponding step number = initial value ?
No
Yes
B2
Input packet present in reception queue ?
No
Yes
B3
Increment corresponding step number
B4
Select input packet in reception queue as self candidate, and send that self candidate to all other computers
B5
Protocol data(candidate type) having identical input order number received ?
No
Yes
B6
Step number in received data > corresponding step number ?
No
Yes
B7
Update corresponding step number to step number in received data
B8
Select input packet in received data as self candidate, and send that self candidate to all other computers (store this input packet as another candidate at the same time)
B9
Step number in received data = corresponding step number ?
No
Yes
B10
Store input packet in received data as another candidate
B11
Number of candidates (self candidate + other candidates) ≥ (n - f) ?
No
Yes
End

FIG. 6

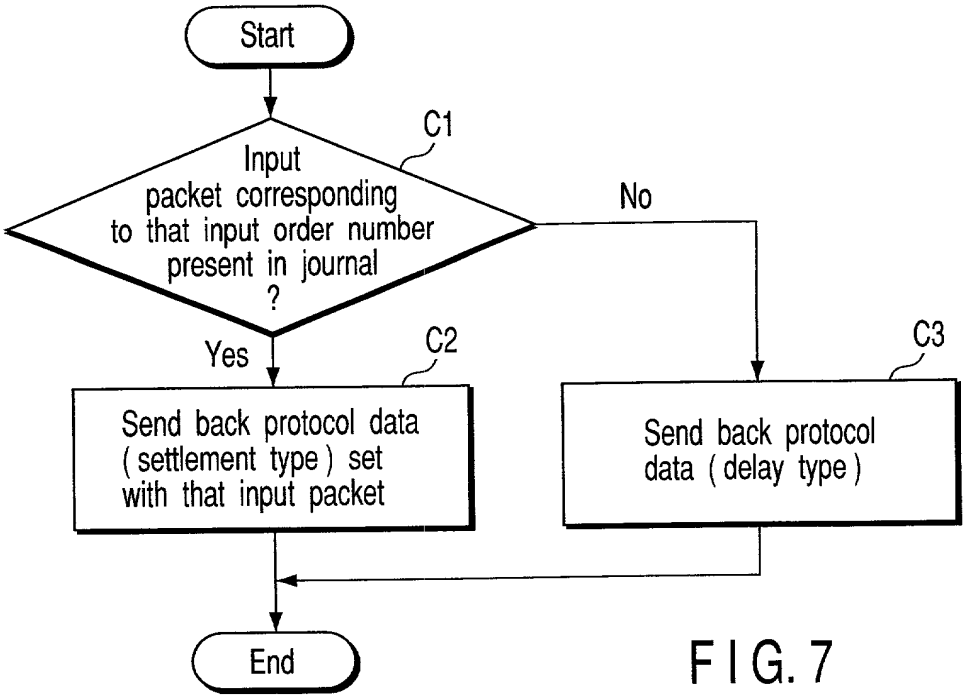
Start
C1
Input packet corresponding to that input order number present in journal ?
No
Yes
C2
C3
Send back protocol data (settlement type) set with that input packet
Send back protocol data (delay type)
End

FIG. 7

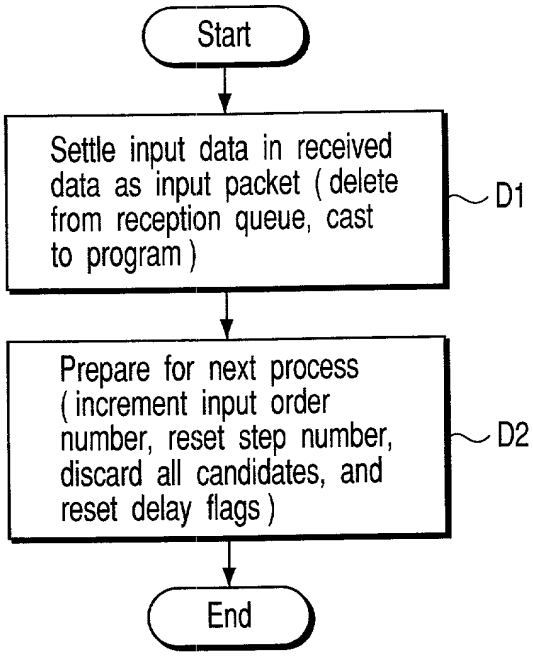
Start
Settle input data in received data as input packet (delete from reception queue, cast to program)
D1
Prepare for next process (increment input order number, reset step number, discard all candidates, and reset delay flags)
D2
End

FIG. 8

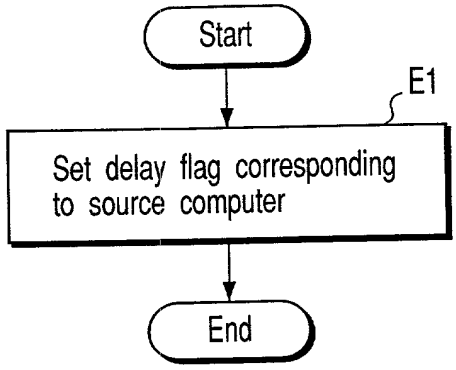
Start
E1
Set delay flag corresponding to source computer
End

FIG. 9

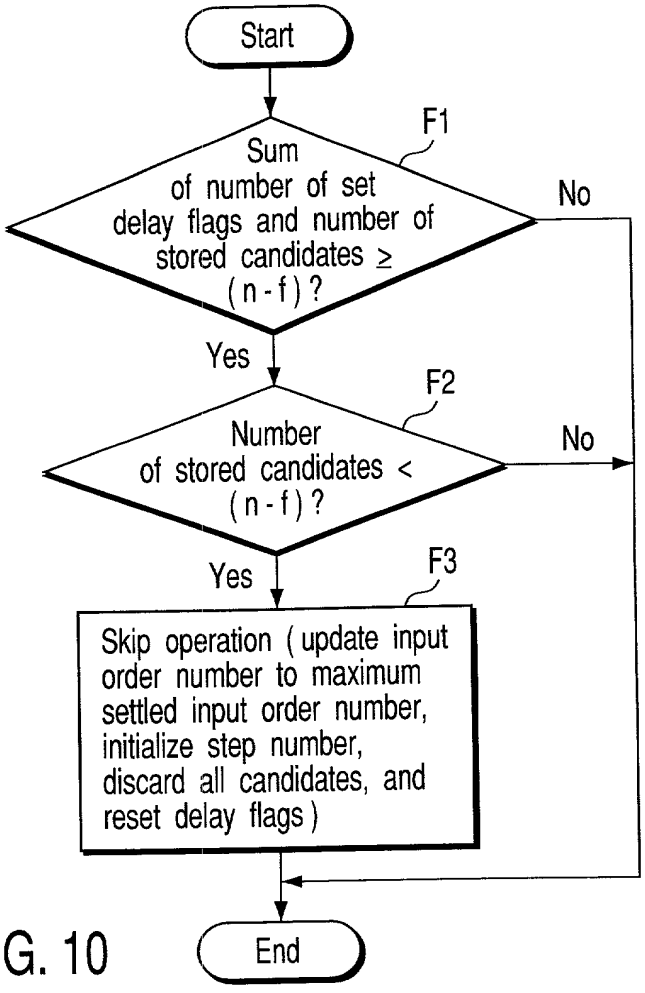
Start
F1
Sum of number of set delay flags and number of stored candidates ≥ (n - f) ?
No
Yes
F2
Number of stored candidates < (n - f) ?
No
Yes
F3
Skip operation (update input order number to maximum settled input order number, initialize step number, discard all candidates, and reset delay flags)
End

FIG. 10

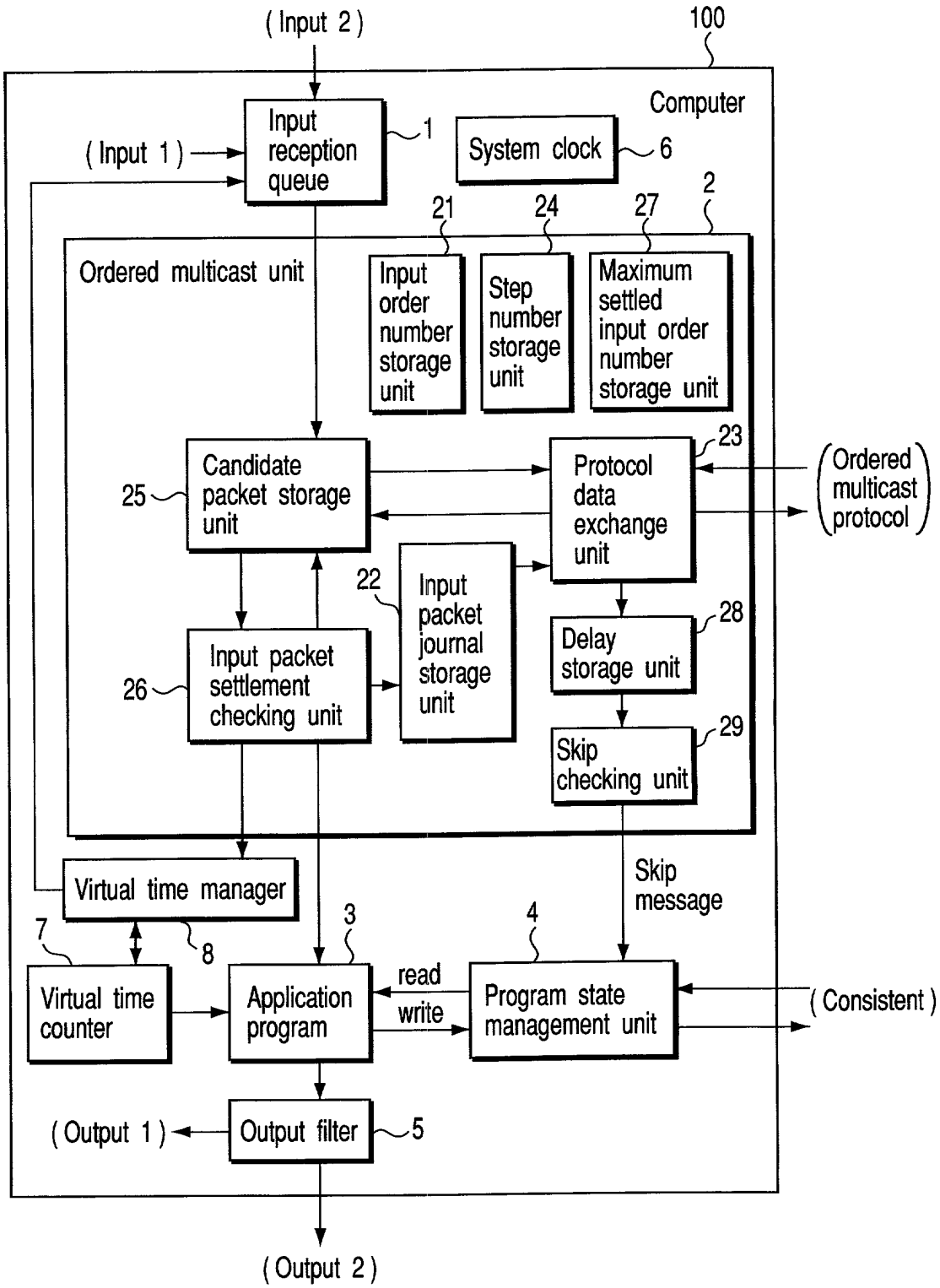
(Input 2)
100
Computer
Input reception queue
1
(Input 1)
System clock
6
2
21
24
27
Ordered multicast unit
Input order number storage unit
Step number storage unit
Maximum settled input order number storage unit
23
Candidate packet storage unit
25
Protocol data exchange unit
(Ordered multicast protocol)
22
Input packet journal storage unit
28
Delay storage unit
26
Input packet settlement checking unit
29
Skip checking unit
Virtual time manager
Skip message
7
8
3
4
Virtual time counter
Application program
read
write
Program state management unit
(Consistent)
(Output 1)
Output filter
5
(Output 2)

FIG. 11